NEW AIRBORNE SET

SEARCH RECEIVER ARl.5876.

Radio Frequency.	200-245 Mc/s (Preset to 243 Mc/s).
Receiver Sensitivity.	3 microvolts for 2 to 1 signal/noise ratio.
Range of Reception.	Airborne aerial at 10,000 ft. above sea level. 70-75 nautical miles over sea. 40-45 nautical miles over land. Seaborne aerial at 25/30 ft. above sea level 5-7 nautical miles.
Power Consumption.	80 or 115 VAC 75 VA; 24V DC 3 W ⟶ Amps ?
Weight.	Receiver Unit Ref. 10D/19540 10 lbs. Power Supply Unit Ref. 10K/18240 5½ lbs.
Dimensions.	Receiver 9½" length. 6" height. 4" width. Power Supply Unit 3½" length. 6" height. 4" width.

Input from the port and starboard aerials is connected to one pair of fixed contacts in the aerial X-plate change-over relay. This relay is controlled by the search-homing switch, part of the function switch and a motor driven three-speed cam-operated switch. The moving contact associated with the pair of fixed contacts is connected to the input of the RF unit.

One stage of RF amplification followed by a tuned local oscillator and mixer form, together, the RF unit.

The RF unit is followed by four stages of IF amplifications. Bias voltage to vary the gain is applied to the grids of the second and third IF valves and is derived from an AGC circuit in the IF unit when the function switch is in the RT/RX position. When receiving beacon signals (RXB) this bias voltage comes from the negative 48V bias line via the manual gain control variable resistor. The fourth IF amplification stage is followed by a detector which is in turn connected (via a cathode follower) to the video amplifier in the timebase.

In the timebase, the output from the video-amplifier is connected to one of the moving contacts in the aerial CRT switching relay. It is applied from this moving relay contact, in turn, to either of the CRT X-plates. An output connection is also made from the video amplifier to the timebase limiter valve which serves to regulate the triggering pulses into the timebase valve.

The timebase valve is connected to one of the Y-plates of the CRT and a signal to suppress the fly-back is applied from the timebase valve to the grid of the CRT.

Also included in the transmitter unit is a coding circuit providing similar pulses to those of the beacon.. This circuit is connected between the oscillator grid and earth when the function switch is at TXB. It enables the transmitter to transmit coded signals of the same nature as the man-carried beacon signals. This enables a rescue craft (airborne or rescue launch) to home on to the search aircraft which circles the survivor until the rescue craft is sufficiently near to detect the survivor's beacon signal.

A connection is taken via the condenser C222, from the anode of the output valve (V205) to the germanium crystal MR202. This crystal rectifies the signal and applies it as a biasing voltage to the grids of V202 and V203 so as to provide AGC. This circuit is only effective on R/T and although remaining connected in all cases, its action is neutralized by the connection of the manual gain control circuit in other positions of the function switch (Fig. 1).

Timebase Unit.

A circuit diagram of the timebase unit is shown in Fig. 5. The input from the IF unit is passed to the grid of the video amplifier (V301) through the condenser C301, while the germanium crystal MR301 ensures that the signals to the grid are always positivewith respect to the cathode. Output to the CRT X-plates, through the contacts of the "Aerial/X-plate" switch (Fig. 1 and 8) is taken from the anode of this valve (V301). The anode of the valve V301 is also connected, via the condenser C303, to the grid of the timebase limiter valve, V302. This valve and associated circuit serves to maintain substantial equality of triggeringsignal to the timebase, by the suppression of both the top and bottom of the incoming pulses. This materially reduces the effects of external noise, and ensures an even response to the incoming signals, irrespective of equality.

The timebase has a duration of approximately 330 µS, of which the first part is suppressed. The normal duration of suppression is 80 µS, the preset variable resistor RV302 providing the control. The flyback is also suppressed, by the connection of the anode of the timebase valve (V303), through thecondenser C306, to the CRT grid circuit (Fig.6).

A standard blocking oscillator is connected between the screen-grid of V303. This is held cut off by the grid bias from the trigger control (RV301). When the signal arrives from the limiter valve V302, it is fed via C308 onto the grid of V303. This causes V303 to fire and discharge the timebase condenser C313 connected between the anode of V303 and earth.

The pulse fed back from the screen of V303 to the grid, via transformer TR301, charges negatively the grid condensers C307 and C309. The rectifier V307 being cut off, the negative charge on the condensers leaks away via R311 to that the grid of V303 rises until it is caught by V307 at the potential determined by the trigger control RV301.

The circuit is now ready for firing by another pulse; but, during the time the negative charge is present, the limited pulses from the valve V302 are of insufficient amplitude to cause triggering. In the meantime, C313 is charged via RV303 and R312 until it is caught by V304 at a potential determined by RV304. This voltage rise is fed to the Y1-plate of the CRT as the timebase wave-form. It is also fed via R317 to the grid of the paraphase amplifier V305 and from the anode of V305 via C318 to the othe timebase plate (Y2) of the CRT.

Negative feed-back, via R321 to the grid of V305, ensures unity gain in the paraphase amplifier valve V305.

The valve V306 is a DC restoration diode operating on the output of V305 to ensure that in all conditions the timebase starts at the same point.

The relays $\frac{A}{2}$ and $\frac{B}{2}$ are controlled by the function switch (S502 of Fig.7), the relays being energized when the function switch is in the R/T position. These relays are included in the circuit to effect the switching from receive beacon (RXB) to receive speech (RXR/T). The operation of these relays serves to alter the timebase repetition frequency, to connect the integrator circuit to the grid of the paraphase amplifier V305)and to connect the anode of this valve to the audio output transformer

A crystal-controlled oscillator circuit for providing a check on the receiver frequency is alsò included in the transmitter unit.

RF Unit.

The circuit diagram of this unit is shown in Fig. 3 and it will be seen that it consists of three stages which are as follows:-

(1) A pair of triodes (V121 and V122) connected as a cascade circuit forming the RF input stage.

(2) A mixer (V123).

(3) A local oscillator (V124).

The input stage, consisting of the two triodes (V121 and V122), is connected as a cascade circuit, the grid-anode capacitance of V121 being neutralized by the inductance L122. This circuit gives improved second-channel rejection compared with the single grounded grid stage and also a slight improvement in noise factor.

The output from V122 is fed to the grid of the mixer (V123) via the condenser C127 and the tuned inductance L124.

The local oscillator is a grounded-cathode Colpitts circuit, the frequency being determined by the variable inductance L125, in conjunction with the condensers C129 and C132 and the inter-electrode capacitances of the valve (V124). Theinductance L125 consists of a single U-shaped loop and its inductance is varied by the rotation of an eccentric metal disc (Fig. 4) within the loop.

The output from the oscillator is taken via C128 to the cathode of the mixer (V123).

The output from the mixer stage is passed to the IF unit via the transformer TR121.

IF Unit.

A circuit diagram of the IF unit is shown in Fig. 2. This unit consists of four stages of IF amplification, V201 to V204 which are followed by a germanium crystal, MR201, acting as a detector feeding a cathode-follower ouput valve, V205.

A second germanium crystal, MR202, provides rectification for the AGC circuit which operates on speech reception.

The coupling of the first two stages (V201 and V202) is by the condensers C205 and C209. Tuning is achieved by means of the variable inductances L202 and L204 in the respective anode circuits (V201 and V202). The two later stages of amplification V203 and V204, are both tuned and coupled by the transformers TR201 and TR202. The tuning of all stages is arranged to pass a band 800 kc/s wide and a high overall gain is thus achieved. The mid-point of this band is at 39.5 Mc/s.

The output from V204 is passed to the grid of the cathode-follower output valve V205 through the germanium crystal MR201 and its associated network (the detector circuit), and from the cathode of the output valve V205 to the video amplifier in the timebase unit (Fig.1 and 5).

TR302 since, in this condition, it is acting as the audio output amplifier valve.

In more detail, when the relay $\frac{A}{2}$ is de-energized, the contact A1 connects the condenser C309 in circuit for the receive beacon (RXB) condition. When the relay is energized, the contact A1 disconnects the condenser C309 from the circuit for the receive speech (RXR/T) condition.

The relay contacts A2 and B1, when in the R/T condition, connect the integration circuit, formed by the condensers C311, C305, C312, C314, C315 and the resistors R314, R315, R316 and R320 in the grid circuit of the timebase inverter valve V305. At the same time, the anode circuit of this valve is switched by the relay contact B2 from the timebase output circuit to the audio output transformer TR302. In theR/T condition the valve V305 acts as an audio amplifier to feed TR302 which has an output impedance of 100 ohms.

CRT Circuit.

A circuit diagram for the CRT and controls is shown in Fig. 6.

The timebase output (Fig. 1 and 5) is applied to the Y-plates of the cathode-ray tube (V501 of Fig. 6) to provide the vertical trace. The pulse signal from the video amplifier in the timebase unit is connected to the X-plates via the combined aerial X-plate switching relay (Fig. 1 and 8).

The CRT (V501 of Fig. 6) has a 4-volt supply for the heater and 1.5kV negative is used for the EHT supply to the CRT anode, i.e. pin 4. There is also a post-deflection accelerator using 1.5kV positive and this accelerator anode is connected to the side cap of the CRT.

Aerial switching.

A circuit diagram of the aerial switching is shown in Fig. 8. A view of the drag cup motor and the triple-cam-switch timing contacts is shown in Fig. 4.

The drag cup motor used to drive the local oscillator variable inductance in the RF unit (Fig. 2 and 3) is also used to operate the aerial X-plate change-over relay $\frac{C}{2}$ (Fig. 1 and 8) by means of cams (Fig. 4 and 8) which open and close contacts. Three sets of cams and contacts are fitted, giving cyclic rates of 6 per minute, 30 per minute and 15 per second.

An oscillator proviees a supply of constant voltage and frequency to the drag cup motor (Fig. 7 and 8).

It will be seen by reference to Fig. 8 that the triple-cam-switch timing contacts are connected by way of the plug 201 and socket 601 on the IF unit, the function switch S502 and the SEARCH-HOMING selector switch S501 to the change-over relay $\frac{C}{2}$. This relay has a suppressor resistor (R513 of Fig. 7) connected across thecoil and a delaying resistor in series, to give substantial equality of opening and closing times. It is fitted with two sets of change-over contacts (Fig. 7) suitable for RF use. In one set the fixed contacts are connected to the port and starboard aerials respectively, whilst the moving contact is connected to the RF input. In the other set, the fixed contacts are connected to the X-plates of the CRT and the moving contact to the video output. These contacts are so arranged that the port aerial is connected to the input at the same time that the video output is connected to the X2 plate and, similarly, for the starboard aerial and the X1 plate.

When the function selector switch is at TX R/T or RX R/T, the 24V supply to the coil of thechangeover relay (via the triple cam switch timing contacts) is interrupted (Fig. 8) and the relay, in its released position, leaves the port aerial connected. This aerial is used for R/T reception, whilst a separate aerial is used for R/T transmission.

Transmitter Unit.

A circuit diagram of this unit is shown in Fig. 9. A circuit diagram of the HT switching for the receive or transmit condition is shown in Fig. 10.

Refering to Fig. 9, the circuit consists of a Hartley triode oscillator, V405, driving the cathode of a second triode V404 used as a power amplifier. The audio frequency signals from the microphone are passed to the grid of the preamplifier valve, V402, through the transformer TR401. The output from the anode of this valve is fed to the grid of the modulator-power amplifier valve V404, by way of a cathode-follower (403). Over modulation is prevented by a biasing voltage applied to the grid of V403 through the rectifier MR401.

As mentioned in para. 48, the carrier frequency is produced by a Hartley oscillator circuit (V405). The output from V405 to the cathode of the power amplifier V404, is inductively coupled by L403, a Multiple-wound inductor, the tuning of which is ganged with that of the power amplifier output transformer TR402. The secondary of TR402 is connected to the coaxial aerial lead.

Coding circuit.

The coding circuit enables the transmitter to be pulse modulated in the same manner as the man-carried beacon. This enables a rescue craft (airborne or rescue launch) to home on to the search aircraft which circles the survivor until the rescue craft is sufficiently near to detect the survivor's signal. Further operational details of this circuit are given in Chapter 7.

The circuit (Fig.9)consisting of R413, C413, L404 and R416 provides a pulse coding circuit when the function switch is at TXB, so permitting the transmission of a signal similar to that of the SARAH beacon. This pulse coding circuit is similar to that used on the man-carried beacon described in para. 66 to 76 of this Chapter.

When the function switch S502 (Fig. 1 and 7) is in the TXB position the coding circuit forms the only path to earth and is therefore operative. The coding unit injects a signal into the grid of V405 (Fig. 9).

or RT/RX

When thefunction switch S502 (Fig. 1and 7) is in the RT/TX/position, this connects the grid of V405 (Fig. 9) to earth through R415 and effectively short-circuits the coding unit.

Crystal Check Circuit.

A separate circuit embodied in the transmitter unit is a crystal controlled oscillator (V401 of Fig. 9) providing an accurate check on the receiver frequency when the function switch is set to XTAL CHECK. The circuit is tuned to the 15th harmonic of a 16.2 Mc/s crystal.

The output from the crystal check circuit (V401 cathode) is taken to pin 7 of plug 401 and thence to the "Aerial-switching-relay"(RL $\frac{C}{2}$ of Fig.7)

end of the metal braiding on the port aerial coaxial lead. The other end of this metal braiding is connected to chassis at the aerial socket where it is earthed. It should be appreciated that this lenghh of metal braiding forms an impedance to the crystal RF currents and there is sufficient radiation from the relay screening bars (E2 of RL C_2) to the relay spring sets to provide the necessary coupling between the output of the crystal circuit and the input of the RF unit.

"Tune TXB/Tune TX" condition (Fig. 11).

The use of this facility assumes that the receiver has already been accurately tuned to the frequency of the survivor's beacon. When the function switch S502 (Fig. 11) is in the TXB/TUNE TX position both the airborne receiver and the airborne transmitter are operating simultaneously and the coded signals radiated from the transmitter aerial can be picked up by the receiver. The responses will be seen on the CRT screen together with those of the survivor's beacon.

In order to assurethat the transmitter is tuned to exactly the same frequency as the survivor's beacon the transmitter TUNE TX control is adjusted until the local signal responses on the CRT are as large as possible. This will indicate that the receiver and thetransmitter, as well as the survivor's beacon, are all operating at the same frequency.

Power Unit Type 8094.

A circuit diagram of the power unit is shown in Fig. 12.

Power input supplies are connected to the plug PL1 (POWER) as follows:-

24V DC

80V AC^x

or

115V AC^x (^{x} as required)

The socket SK501 is used to connect the various outputs of the power unit to the transmitter-receiver.

The input transformer TR1 is designed to operate from an input voltage of 80 or 115V. The tappings on the voltage adjustmentpanel are adjusted to coincide with the search and rescue craft supply.

The valve V1 is a halve-wave directly heated rectifier for the negative EHT supply (- 1.5 kV). The heater supply for this rectifier is provided by an "overwind" on the 1000V winding to give 1.44V. The valve V2 is a half-wave directly heated rectifier for the positive EHT supply (+ 1.5 kV). The heater of this valve is supplied by an isolated winding on TR1 having an insulation for 1.5 kV. The condenser C4 is for smoothing. The + 1.5 kV supply also feeds, through suitable voltage dropping resistors (Fig. 6), 400V to the timebase unit.

The valve V4 is connected in a full-wave rectifier circuit and the 150V DC supply is smoothed by C5, C6, C9 and L2. This 150V DC supply is fed to the IF, timebase and transmitter units.

The valve V3 is a half-wave rectifier. The rectifier provides an additional 150V which is returned to the 150C HT line from V4 to give an output of + 300 V DC. The 300V DC output is smoothedby the condensers C1 and C2 and the choke L1. This DC supply is fed to the timebase and transmitter units.

The diode valves V5 and V6 are used in the bias supply to give full-wave rectification. A -50V DC supply is available for bias to the IF, timebase and transmitter units.

Two 6.3V AC output windings are provided on the transformer TR1 for the valve heaters as well as a separate 4V AC output for the CRT heater.